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THE RELATION BETWEEN ADMISSION BALANCE AND FUNCTIONAL OUTCOMES FOLLOWING STROKE REHABILITATION: A MEDICAL CENTER BASED STUDY

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This prospective study evaluated the clinical use of the Fugl-Meyer Balance Scale (FMBS) on stroke patients during hospitalization and assessed the relationship between balance score at admission to the rehabilitation program and functional outcome at discharge. One hundred and sixty-three stroke patients admitted to the in-patient rehabilitation department of a university-based medical center between January 1 and December 31, 1997 were recruited for this investigation. Functional ability was evaluated with the Functional Independence Measure (FIM™) instrument, and balance was measured using the 7-item Fugl-Meyer Balance Scale. These measures were assessed both at admission to and discharge from the inpatient rehabilitation program. Pearson correlation and multiple regression analyses were used to determine the relationship between balance and functional ability scores at admission and rehabilitation outcomes at discharge, including length of stay, functional gain, and efficiency. The results demonstrated that the balance score at admission accounted for 6% of the variation in length of stay, once demographic influences were controlled. The FIM efficiency score could possibly be predicted by the balance ability at admission, which accounted for 3% of the variance. However, the balance score could not provide predictive information about the FIM gain beyond that already provided by the FIM score at admission, which accounted for 4% of the variance with demographic factors controlled. Overall, balance ability at admission, assessed by the Fugl-Meyer Balance Scale, had no, or at least only little, contribution to account for the variance in rehabilitation outcomes. These findings suggest that the use of Fugl-Meyer Balance Scale at admission to stroke inpatient rehabilitation seemed not to enhance the ability to predict rehabilitation outcomes.

Key words: stroke, balance, rehabilitation outcome

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Postural adjustments act to keep the body's center of gravity close to the center of the base of support to maintain balance[1]. Adequate balance is crucial for performing most functional activities. Balance, contributing to static and dynamic postural stability, has three basic components: maintenance of position, stabilization of voluntary movements, and reaction to external disturbances. Loss of any component will affect balance reaction, and subsequently, function.

Impairment of balance results from a variety of reasons, such as pathophysiological changes of neuromuscular system associated with illness or injury, complications of medications, or the normal aging process. As to physical therapists, assessing and improving balance ability is an es-

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sential component for treatment of balance disorders, especially those with a neurological pathology, in rehabilitation programs[2].

Traditional methods of balance assessment have focused on the maintenance of posture, balance during weight shifting or movement, and responses to perturbation[3-5]. It is difficult to find a single, simple test to assess balance, largely due to the nature of balance reaction that involves complex sensorimotor processing. Many balance tests exist, but not all tests are appropriate for all patients. Several studies have found balance capability to be one of several predictors of functional outcomes in stroke rehabilitation[6-10]. However, these studies did not use a standardized, widely accepted, and practical measurement of balance. A number of approaches have been taken for developing measures of the ability to balance[11-19]. Among them the Fugl-Meyer sensorimotor assessment (FMSA) has been claimed to have both face and concurrent validity[20,21]. The entire instrument that included seven measurable balance subitems has been used to measure physical performance in hemiplegic patients and has shown to have a good correlation with the Barthel Index[11]. To the authors' knowledge, the relationship between Fugl-Meyer balance scale and stroke rehabilitation outcomes has not been studied.

The present study had two objectives: 1) to evaluate the relationship between a measure of balance and a measure of functional independence; and 2) to determine if balance scores collected at rehabilitation admission were predictive of rehabilitation outcomes, including length of rehabilitation stay, improvement in functional independence scores, and rehabilitation efficiency.

MATERIALS AND METHODS

Subjects

One hundred and sixty-three patients (93 males and 70 females) with a diagnosis of cerebrovascular disease (International Classification of Diseases [ICD][22] codes 430-434, 437-438) were recruited in this prospective study. They were admitted to the inpatient rehabilitation department of our university hospital between January 1, 1997 and December 31, 1997. Consented subjects were assessed by the same senior physical therapist within 3 days of referral to the rehabilitation department for initial evaluation and reassessed within 48 hours of discharge from the department ward when functional recovery reached a plateau.

Balance ability was measured to perform the FMSA balance subtest (Appendix 1). It is a 7-item scale that mainly measures the amount of assistance and the time tolerated during static standing balance and equilibrium reactions. A three-point ordinal scale is applied to each item: 0) the

Appendix 1. Fugl-Meyer sensorimotor assessment of balance performance

Test	Scoring
1. Sit without support	0—Cannot maintain sitting without support
	1—Can sit unsupported less than 5 minutes
	2—Can sit longer than 5 minutes
2. Parachute reaction, non-affected side	0—Does not abduct shoulder or extend elbow
	1—Impaired reaction
	2—Normal reaction
3. Parachute reaction, affected side	Scoring is the same as for test 2
4. Stand with support	0—Cannot stand
	1—Stand with maximum support
	2—Stand with minimum support for 1 minute
5. Stand without support	0—Cannot stand without support
	1—Stand less than 1 minute or sway
	2—Stand with good balance more than 1 minute
6. Stand on non-affected side	0—Cannot be maintained longer than 1-2 seconds
	1—Stand balanced 4-9 seconds
	2—Stand balanced more than 10 seconds
7. Stand on affected side	Scoring is the same as for test 6

detail cannot be performed, 1) the detail can be partially performed, and 2) the detail can be fully performed. The maximum score for balance subtest is 14.

Functional recovery was measured as improvement in the ability to perform the Functional Independence Measure (FIM) instrument[23]. The FIM is an 18-item, 7-level scale that is used to assess the patient's need for assistance or devices in order to accomplish daily activities in six areas: self care, sphincter control, transfers, locomotion, communication, and social cognition. The change in FIM scores from the beginning of rehabilitation therapy to discharge from the department was calculated as one measure of functional gain. An efficiency index[24] of rehabilitation gains was computed by dividing this functional improvement by the length of rehabilitation stay. The length of rehabilitation stay, measured in days, is the time from rehabilitation commencement to discharge.

Data analysis

Descriptive statistics were calculated for all subjects with respect to the demographic data, clinical factors, balance scores, and FIM scores. Pearson's correlation coefficients were used to analyze correlation between the balance scores and functional outcome scores. Multiple regression analyses were performed to identify the relationship between balance and functional ability at admission and rehabilitation outcomes at discharge. All of the regression analyses were run in three steps. Firstly, factors such as age, gender, main language and marital status were forced into the model. In the second and third steps, scores from FIM score and FMBS at admission were individually entered as potential predictors of rehabilitation outcomes. This multiple regression approach was intended to evaluate the relative contribution of balance and functional ability data collected at admission about the prediction of rehabilitation outcomes while controlling for the possible influence of demographic factors. The SAS 6.04 (SAS Institute, Cary, NC, USA) was used for all analyses. For all statistical tests, the significant level was set at alpha = .05.

RESULTS

Descriptive statistics for demographic data, diagnostic findings, balance scores, and FIM scores are shown in Table 1. Ninety-three (57.1%) of total stroke patients were male. The average age of onset of stroke among 163 patients was at 64.1 years old. The average length of time from stroke onset to the beginning of rehabilitation therapy was 24.9±21.2 days. The average length of rehabilitation stay was 34.4 days. The mean balance score was 4.3 at admission, compared with 6.7 on discharge. The mean FIM score was 55.2 at admission, compared with 72.2 on discharge.

Table 1. Basic data of stroke patients (n=163)

Item		No. (%)
Gender	Male / Female	93 (57.1) / 70 (42.9)
Age (year)		64.1 (11.3)*
Onset to rehabilitation commencement		24.9 (21.2)*
Rehabilitation stay (day)		34.4 (17.2)*
Admission Fugl-Meyer Balance score		4.3 (3.6)*
Discharge Fugl-Meyer Balance score		6.7 (3.8)*
Admission FIM score		55.2 (23.9)*
Discharge FIM score		72.2 (27.2)*
FIM gain		17.0 (17.0)*
FIM efficiency		0.61 (0.73)*
Stroke type	Infarction / Hemorrhage	100 (61.3) / 63 (38.7)
Side affected	Left / Right / Bilateral	72 (44.2) / 65 (39.8) / 26 (16.0)
Number of attack	First / Recurrent	114 (69.9) / 49 (30.1)
Language	Taiwanese / Others	148 (90.8) / 15 (9.2)
Marital status	Married / Others	118 (72.4) / 45 (27.6)
Main care giver during hospitalization	Family / Care giver	103 (63.2) / 60 (36.8)

* Mean ± Standard Deviation

Table 2. Pearson's correlation between balance and age, FIM scores, and outcome measures (n=163)

Variable	Admission balance score		Discharge balance score	
	r	p	r	p
Admission FIM score	0.59	0.0001	0.57	0.0001
Rehabilitation stay	-0.25	0.0011	-0.15	0.0610
FIM gain	0.07	0.4077	0.44	0.0001
FIM efficiency	0.21	0.0084	0.45	0.0001

FIM = Functional Independence Measure

Table 3. Multiple regression analyses comparing balance score with FIM score at admission as predictors of rehabilitation outcomes (n=163)

Predicted variable	Independent variables	R^2	Adjusted R^2	R^2 change
Rehabilitation stay	Step 1: A	0.0588	0.0288	——
	Step 2: A+B	0.1721	0.1403	0.1133
	Step 3: A+C	0.1135	0.0794	0.0547
FIM gain	Step 1: A	0.0380	0.0074	——
	Step 2: A+B	0.0762	0.0406	0.0382
	Step 3: A+C	0.0398	0.0029	0.0018
FIM efficiency	Step 1: A	0.0292	-0.0017	——
	Step 2: A+B	0.0303	-0.0070	0.0011
	Step 3: A+C	0.0605	0.0243	0.0313

FIM = Functional Independence Measure;
A = Demographic variables;
A = with demographic variables controlled;
B = Admission FIM score;
C = Admission balance score.

The mean FIM gain was 17.0. The mean rehabilitation efficiency was 0.61. The findings of medical examination included the stroke types, the affected limbs, and number of attacks. One hundred subjects (61.3%) were thromboembolic and the other 63 (38.7%) were hemorrhagic. Seventy-two (44.2%) had an affected limb on the left side, sixty-five (39.9%) on the right side, and twenty-six (16.0%) on bilateral sides. Forty-nine (30.1%) patients had previous stroke history. As to main language, 90.8% of subjects spoke Taiwanese. In marital status, 118 patients (72.4%) were married and 45 (27.6%) were divorced or widowed. Sixty (36.8%) patients hired caregivers during hospitalization.

Table 2 shows the Pearson's correlation coefficients. At admission, balance score was positively correlated with the FIM score and rehabilitation efficiency score, but negatively correlated with rehabilitation stay. No relationship was present between the balance and the FIM gain scores. The item scores at discharge indicated there was no relationship between balance score and rehabilitation stay. Balance score at discharge was significantly correlated ($p < 0.0001$) with admission FIM score, FIM gain, and FIM efficiency. Table 3 shows the results of regression analyses of comparison between balance and FIM scores at admission as predictors of outcomes, with demographic variables taken into consideration. With demographic variables influences controlled, balance score at admission accounted for 6% of the variance in the length of rehabilitation stay. On the other hand, the FIM score can provide 11% of the variance. FIM gain score was predicted by FIM score at admission explained 4% of the variance above and beyond the influence of demographic variables, but the balance score did not provide any predictive variance. The balance score at admission accounted for 3% of the variance in FIM efficiency score with demographic variables controlled, but FIM score did not provide significant predictive information.

DISCUSSION

In this study, Fugl-Meyer balance score at admission was shown to have a moderate relationship to the FIM score($r=0.59$, $p<0.0001$). This finding supports the view that balance has an important contribution to overall functional ability. Therefore, for stroke patients, there is considerable scope for balance training to start as soon as possible to improve the ability of activities of daily living. Moreover, the negative correlation between admission balance score and the length of rehabilitation stay implies that better balance ability may shorten the length of rehabilitation and hospitalization, and, presumably, lower the cost of rehabilitation.

On the other hand, the result from this study indicates that balance problems at rehabilitation admission do not put a limit on patients' potential for functional improvement after stroke rehabilitation. This finding is similar to that of Nichols *et al.*[10], who also demonstrated little relationship between balance and FIM gain score. However, whereas in our study an easily administered clinical instrument was used, Nichols et al. used an expensive computerized force plate, and not generally available system.

Additionally, Juneja *et al.*[25] used the 14-item, 5-point ordinal Berg Balance Scale to evaluate a heterogeneous acute inpatient rehabilitation population. Their findings suggested that routine assessment of Berg Balance Scale at admission might enhance the ability to predict rehabilitation outcomes beyond that provided by assessment of functional status alone. The primary finding of our study was the weak relationship between the Fugl-Meyer balance score and aspect of the rehabilitation outcomes. The Fugl-Meyer balance score only accounted for 6% of the variance in the length of rehabilitation stay with demographic variables controlled. Balance also could not predict FIM gain, and only accounted for 4% of the variance on FIM efficiency score. Since the FIM efficiency score is a ratio between FIM gain and the length of rehabilitation stay, it is likely that the poor relationship between the Fugl-Meyer balance score and FIM efficiency score further reflects the association between balance and the length of rehabilitation stay. Based on our finding, assessing both FMBS and FIM score during the initial rehabilitation evaluation for stroke patients seems not to be recommended. Despite these unexpected results, the Fugl-Meyer balance scale demonstrates as a simple and quantitative measure of balance. Future study with the comparisons among clinical measures of balance such as Fugl-Meyer balance scale, Berg Balance Scale, and computerized force plate system would be beneficial.

This prospective study of 163 stroke rehabilitation inpatients demonstrates the clinical usefulness of the Fugl-Meyer balance scale for this population. The initial balance score was positively correlated to the FIM score and rehabilitation efficiency score. However, it was shown to account for 6% of the variance in the length of rehabilitation stay. The FIM efficiency score was predicted by the balance score, with only 3% of the variance accounted for. The balance score did not demonstrate predictive value for FIM gain. These findings seem not to be helpful in setting goals in relation to predicted functional outcomes for stroke rehabilitation. Further investigation regarding outcome prediction with varied clinical scales, supplemented by more objective measurement, is necessary to clarify the relationship between impairment and disability and optimization of rehabilitation outcome.

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腦中風患者住院時平衡能力和復健後功能的關係：一項醫學中心的研究

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本研究目是以前瞻性方式探討住院復健科的腦中風患者臨床使用福格-米勒(Fugl-Meyer)平衡量表來評估住院時平衡能力和復健治療預後功能結果的相關性。本研究以高雄醫學院附設中和醫院民國八十六年一月至十二月期間因腦中風住院在復健病房接受復健治療之患者163位為對象。在剛住院復健科和出院時，分別使用福格-米勒平衡量表來評估平衡能力和使用日常生活功能獨立自主量表(Functional Independence Measure)來評估日常生活功能狀況。並且依據接受復健治療住院天數長短和生活功能獨立自主量表得分進步情形和效率(Efficiency)，做為評估預後功能結果的指標。先以皮爾森相關係數檢定平衡能力和預後功能結果的相關性。而後複迴歸統計分析結果顯示: 當調整基本人口學因素後，評估住院初期平衡能力可以解釋接受復健治療住院天數6%的變異量及復健治療效率3%的變異量;然而，除了評估住院初期生活功能得分分數可以解釋接受復健治療期間生活功能得分進步情形4%的變異量外，平衡能力無法提供解釋生活功能得分進步情形的變異量。這些結果說明住院復健科初期臨床使用福格-米勒平衡量表來評估平衡能力似乎無法有效預測中風病患接受復健治療預後功能結果。

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